Storage and Care of KODAK Color Materials

The useful life that people expect from color prints and slides varies from hours and days to many decades. How long a picture will be kept depends on subjective factors that only the person who owns the picture can evaluate. What follows are some suggestions for getting the longest life possible from negatives, slides, and paper prints. For moviemakers, similar information is given in Kodak Publication No. D-23, *Handling and Storage of KODAK and EASTMAN Motion Picture Films.* This pamphlet is an excerpt from Kodak Publication No. E-77, *Kodak Color Films.* The latest edition of *Kodak Color Films* covers handling, processing, and technical data on Kodak still color materials, including data sheets on Kodak Ektachrome films for Process E-6 and color negative films for Process C-41.

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Storage and Use of Unprocessed Color Materials

Adverse storage conditions usually cause larger changes in the color quality of photographic films and paper than does any permissible variation in manufacturing. For this reason, care should be taken in storing these materials from the moment they are purchased. Kodak sheet films and papers are packaged in foil envelopes to protect them from changes in relative humidity; therefore, do not open the original package until you are ready to use the product. Specific storage instructions for each product are printed on its package, but here are a few general principles to keep in mind.

Use it promptly. The normal changes in photographic characteristics that occur with age can be retarded by proper storage conditions. Nevertheless, for best results, use film before the expiration date printed on its package.

Keep the relative humidity low. Although the types of packaging used help protect the materials from the effects of dampness, a relative humidity (RH) of 60 percent or higher for long periods is damaging to cardboard packages, labels, adhesives, and metal containers. It also promotes the growth of bacteria, molds, and fungi. Some species of fungi can destroy emulsions by digesting the gelatin. Usually, the relative humidity in refrigerators and freezers is high, and although sheet film and paper are protected by foil envelopes, the package (cardboard boxes, metal cans) should be inspected periodically for signs of deterioration and fungus growth. Inexpensive sling psychrometers are available for checking the relative humidity of rooms where film and paper are stored, and simple indicator strips for less precise measurements can be obtained. Room dehumidifiers can be used to keep the humidity low, ideally below 50 percent RH.

Keep the temperature low. Kodak color films for general use are intended for recreational—that is, snapshot—picture-taking, and it is expected that they will be stored at normal room temperature. They must be protected from excessive heat such as can occur in the glove compartment, trunk, or back window of a car. If possible, keep the exposed and unexposed films in an insulated box.

Kodak color films intended for professional use should always be stored under refrigeration at about 10°C (50°F) or lower. Some special-purpose films require temperatures of about −18 to −23°C (0 to −10°F). These films are made very uniformly and are designed to yield optimum quality results close to the time of manufacture. To maintain the quality level and minimal emulsion-to-emulsion variability, refrigeration is needed. Look for the storage temperature that is printed on the carton.

Kodak color papers should be stored at 10°C (50°F) or lower in the original sealed package.

Storing opened packages. When the original sealed envelope has been opened, the material is no longer protected from the damaging effects of high relative humidity and other atmospheric conditions such as chemical fumes.* For this reason, it is important to use the material as soon as possible after the foil envelope has been opened. If partially used packages of paper or film must be stored, close the open end of the envelope by folding it twice, then fasten it along the folded edge with waterproof tape such as vinyl electrical tape. Do this resealing (in the dark, of course) in a place that is free of dust and chemical fumes and that has an RH below 50 percent.

Warm-up after refrigeration. Moisture may condense on the surfaces of film or paper taken from refrigerators and freezers. To avoid damage by condensation, allow the package to warm up to room temperature before breaking the seal. The warm-up time varies with the amount of material and the type of package. Short roll films and magazines take 1 to 1½ hours to warm up. Large packages and rolls of film and paper are best left overnight, or about 10 hours, to reach equilibrium with room temperature.

*Here are some examples of chemical fumes that can be harmful to photographic products: Industrial gases, motor exhausts, paints, solvents, cleaners, mothballs, formaldehydes, chipboard, glues, mildew preventatives, foam-in-place insulation, fabric treatments such as permanent press and stain inhibitors, insecticides, and sulfides.

Latent-Image Keeping

Once the color film or paper has been exposed, it is important for consistent results to minimize latent-image change. The best way to accomplish this is to process the film or paper as soon as possible after exposure. This is particularly necessary with professional color films, since they are optimized for processing very soon after exposure. Lower temperature storage after exposure will decrease latent-image changes. Exposed unprocessed film can be kept in a refrigerator for a day or two without careful sealing. If moisture condenses on the film, the cartridge, or the holder when removed from the refrigerator, allow it to evaporate before you handle the film in processing. Professional films that are to be processed by a distant commercial processing laboratory should be shipped by airmail or air express as soon as possible after exposure. Do not deposit film in a metal mailbox where high temperature may occur, particularly if pickup is delayed.

Likewise, for best results, process exposed color paper on the same day as exposure. To minimize differences in latent-image shifts that may result when the exposed paper is held at room temperature—that is, about 21°C (70°F)—for a period of time, keep the interval between exposure and processing as consistent as possible. For example, hold a test print before processing it for about the same length of time that you expect to hold the subsequent prints before you process them. If it is necessary to hold exposed prints between 8 and 24 hours before processing them, store them at 10°C (50°F) or lower. If an unusual situation arises, and you expect the holdover time to exceed 24 hours, store the exposed prints at −18°C (0°F). Maximum holdover time for exposed prints at −18°C (0°F) is three days. Always allow the prints to warm up to room temperature before you process them.

Storage and Use of Color Negatives, Slides, and Prints

Preserving processed color negatives. Of all color photographic products, processed color negatives are perhaps the easiest to preserve, because they normally are not displayed or otherwise viewed. The terse, familiar advice, "Store in a cool, dry place," can hardly be improved upon, but there are a few other factors to consider that can aggravate fading of negatives.

Keep them clean. Before storing any photographic material, clean it carefully with KODAK Film Cleaner, or equivalent, to remove fingerprints, dirt, and dust. All these things can contain chemicals or fungus spores that might harm a photographic image.

Protect them from light. Light can affect dyes; therefore, store the negatives in a dark place, in metal drawers or file boxes, for example. Metal is preferred over wood or plastic as the construction material. The reason for this is that the latter two may contain preservatives or volatile substances that, over a long period of time, might affect the stored negatives.

Provide proper atmospheric conditions. High temperature and high relative humidity can also affect processed color negatives. A temperature of −18°C (0°F) and a relative humidity of between 25 and 30 percent are excellent conditions for extremely long-term storage. Even minor reductions in temperature have a major impact on the lifetime of an image. See the table below:

Relative Effect of Temperature on Stability of Image Dyes

Storage Temperature °C	Storage Temperature °F	Predicted Time (t)* for 0.1 Density Loss from D=1.0 (at 40% RH)
30	86	½t
24	75	t (normal)
13	55	4t
4	39	16t
−18	0	340t

*As an illustration, if the predicted time for a 0.1 density loss were 20 years, it would be 20 years and 4t would be 80 years.

Refrigeration, in the long run, is a far less expensive and more reliable technique for long-term keeping than any other published method, even if you assume occasional temporary rewarming for various periods as a part of normal use. Virtually no dye changes occur at this condition.

Low temperature and low humidity is not an easy combination to obtain because, as was mentioned previously, refrigerators and freezers usually have high relative humidity. The combination can be

achieved by conditioning the negatives for an hour in a 25 to 30 percent RH atmosphere at 21°C (70°F). A dehumidified room or cabinet can be used if it is free of dust and fumes. In this same atmosphere, insert the negatives into KODAK Storage Envelopes for Processed Film. The envelopes are made of laminated polyethylene, aluminum, and paper and act as a moistureproof barrier that keeps the total amount of water in the film constant during storage. Remove excess air from the package in a low-humidity atmosphere (see *Dehumidifying with Silica Gel,* page 6). Do this by flattening the package as much as possible before you seal it. If several negatives are stored in the same envelope, separate the negatives with sheets of paper. Be sure that the paper is of archival quality, free of acids, sulfites, and peroxides (see the paragraph, *Specifications for Archival Packaging Materials,* page 6). Avoid excessive pressure on stored negatives; do not pack them tightly or stack them.

Such elaborate care is needed only for negatives that are intended to be stored for a very long time. Negatives can be kept for extended periods of time in normal room conditions. In climates where the humidity regularly approaches 60 percent, a dehumidifier or other means of reducing the humidity in the storage area may be needed. (See *Dehumidifying with Silica Gel,* page 6.) If envelopes or plastic sleeves are used to protect the negatives from dust, scratches, and fingerprints, be sure that the material has no potential for harming the negatives (see *Specifications for Archival Packaging Materials*). Keep the storage container away from radiators, warm-air registers, and windows where sunlight can strike it, so that it will not be heated above room temperature. If you place the storage container against the wall, keep it away from places where chimneys or hot-air ducts are located.

Use care in printing color negatives. Color negatives can be printed many times without risk of perceptible fading. Always use a heat-absorbing glass between the lamp and the negative in the printing equipment to guard against physical damage to the negatives from heat. If you know ahead of time that a negative will be printed a large number of times, make several exposures of the scene so that at least one negative can be kept under the best atmospheric conditions while the others are used for printing.

Selecting negative films for stability. Color negative films usually are not subjected to bright light for long periods of time. If care has been taken in their processing (see *Processing Affects Keeping,* page 5), and if they are stored according to the optimum storage recommendations, all Kodak color negative films can be expected to give good results almost indefinitely.

Preserving processed color slides and larger transparencies. Color slides are supposed to be looked at. The way that they are usually viewed makes their preservation similar to that of color negatives. That is, they are usually projected on a screen by a bright light for several seconds, then returned to storage. Larger transparencies usually are viewed in a different way. Often, they are displayed for long periods of time, illuminated from the back by a comparatively low level of light. Sometimes they are subjected to sunlight from the front, if they are displayed in or near windows. The following paragraphs discuss some things to keep in mind for preserving color slides and larger transparencies.

Protect them from light, heat, and humidity. When slides and transparencies are not being viewed or displayed, they should be stored in the same way as color negatives. That is, for very long life, store them in the dark, at a temperature of −18°C (0°F), or lower, and a relative humidity between 25 and 30 percent. The low humidity can be achieved by packaging the transparencies and slides in KODAK Storage Envelopes for Processed Film as described for color negatives. Again, as for negatives, such an elaborate procedure is not needed for all slides. Slides can also be kept for long periods of time in normal room conditions.

Slide mounts and transparency protection. For slides and larger transparencies, cardboard mounts are adequate for most reasonable storage requirements as long as the cardboard is of archival quality (see *Specifications for Archival Packaging Materials,* page 6). Large transparencies should be protected by plastic sleeves. Make sure that the plastic material is of archival quality.

Use metal storage containers. For the reasons listed in the discussion of the storage of negatives, metal file boxes and drawers make the best storage containers for slides and transparencies, particularly when the storage area is not refrigerated. If plastic trays are the most convenient way for you to store slides, test the trays for possible effects on the slides after long-term contact (see *Specifications for Archival Packaging Materials*). Keep the trays in a dark, cool, dry place, away from atmospheric contaminants (see footnote, page 1).

Use reasonable viewing conditions. Experience with fabrics and finishes has informed most people that prolonged exposure to light and heat has an adverse effect on dyes. This is true also of color slides and transparencies. Do not subject valuable original slides to prolonged or repeated projections, such as might be used in a commercial display. The same holds true for larger transparencies. Although, as a rule, the light level is lower in light boxes, prolonged illumination is harmful, especially if the display is struck by direct sunlight, which contains a large amount of ultraviolet radiation. An ultraviolet absorber of the type provided by, for example, Roscoe Labs of Port Chester, New York, should be used for fluorescent lighting displays. For display purposes, make duplicates of your valuable originals on KODAK EKTACHROME Slide Duplicating Film 5071 (Process E-6) or EKTACHROME Duplicating Film 6121 (Process E-6). The originals can then be stored under the best conditions, that is, low temperature, low humidity, and darkness.

Select the best film for your purpose. All Kodak color transparency films are remarkably stable. It must be emphasized that all Kodak slide films are made to be projected, and it is usually not projection that causes image deterioration, if reasonable care is taken as described above. Your choice of a photographic product should be based, first of all, on the considerations discussed in "KODAK Color Films," Kodak Publication No. E-77, in the section, *Guidelines for the Selection of Color Films,* page 4. For slide films, if longevity is the deciding factor, and if the slides are to be stored in the dark, perhaps the best choice is KODACHROME Film. KODAK EKTACHROME Films certainly make a close second choice for long-lasting dark storage of original slides and transparencies, and they withstand the effects of light better than KODACHROME Film. For display transparencies, it is good practice to use an expendable duplicate if you expect hard usage, so as to spare the original photograph. KODAK VERICOLOR Slide Film 5072 and VERICOLOR Print Film 4111 (ESTAR Thick Base), as well as EKTACHROME Duplicating Films 5071 and 6121, are recommended for this purpose.

Preserving color prints. Color prints are everywhere: in wallets, on walls, in albums, on desk tops. Sometimes great care is taken in their preservation; sometimes, no care at all. They are widely accepted because they can be viewed at any time, without special equipment, and because in most cases they can be replaced before they fade or become damaged. There are instances when the negative from which a print was made is not available to make reprints. In those cases, the care of a print becomes very important. Much of what has been said on previous pages about keeping photographic products applies to color prints. The following discussion has reminders of keeping practices that have been already described and a few considerations that are appropriate to color prints specifically.

Provide a cool, dry, uncontaminated storage place. If you have prints that you do not expect to display, or that you wish to store for a long time before you display them, it is advisable to leave them unmounted. The reasons for this are that unmounted prints occupy less space and involve fewer materials that might prove deleterious to the images. The best storage conditions for color prints are the same as those for other color photographic products. Store them in the dark, at −18°C (0°F) or lower, and at a humidity of about 25 percent. Condition the prints at room temperature and 25 percent RH before sealing them in KODAK Storage Envelopes (see details on page 2). Color prints and other materials larger than 8 x 10 inches can be protected from moisture by using three wraps of aluminum foil and sealing the folds and seams with moistureproof tape such as plastic electrical tape (not what is called "friction tape"). Be sure that the storage area and the conditioning room are free of fumes that might be harmful to color prints (see page 1). If several prints are stored in one package, interleave them with archival quality paper.

For convenient access, store prints in albums. A less elaborate way to keep prints, but one which combines ready access with good long-term storage potential, is a photo album. To get the best results from storage in an album, keep it in a place that does not exceed comfortable room temperature and humidity.

> *CAUTION:* Furniture drawers are occasionally contaminated with photographically harmful fumes from mothballs, mildew inhibitors, wood preservers, paints, varnishes, and wood glues.

Since the color prints are in intimate contact with the photo album's pages, verify that all the materials that are used in the construction of the album are of

archival quality. This includes the cover, pages, plastic sleeves, mounting corners or hinges, and ink used for identification (see page 6). Print lacquering is not recommended for optimum stability.

Use care in mounting and displaying prints. Dry mounting tissue is the best material to use for mounting prints. It is available for both hot and cold mounting techniques. Starch paste, animal glue, and rubber cement should not be used. Some synthetic adhesives could be used for mounting small prints, but dry mounting is preferable for all sizes, because the adhesive tissue provides a barrier between the mount, which might contain impurities, and the print itself. This advantage is lost if mounted prints are stored in a way that allows the back of one mount to touch the face of the next print; therefore, interleave prints that are stored in this manner. Also interleave prints that are stored face-to-face. High-quality mounting board (usually called museum mounting board) is essential to the long-term keeping of a print. To be considered for this purpose, a paper product should be free of groundwood, alum, or alum-rosin size and should have a pH of 7 to 9.5 (see page 6). Examination of old photographs indicates that those mounted with wide borders often suffer less from atmospheric deterioration than those with narrow borders. For this reason, it is desirable to mount prints with borders about 8 cm (3 inches) wide at the top and sides and about 9 cm (3½ inches) wide at the bottom. Besides, mounts are sometimes damaged in handling, and wide borders allow for some trimming of the edge.

Protection of a print's surface will help prolong its life. A hinged overlay that covers the print and mount affords some protection from contamination by atmospheric gases or by materials that might otherwise come in contact with the print when it is being stored or transported. Prints that are handled frequently should be protected with a sheet or sleeve of transparent material. Suitable plastics for this purpose are cellulose acetate and polyethylene terephthalate (polyester), both without surface coating. If the prints are framed, they can be protected by a sheet of glass or by a sheet of rigid plastic that has been made so that it absorbs ultraviolet radiation. Lacquering of prints is not recommended for optimum print stability.

Prints cannot always be displayed in a way that promotes long-term keeping. The best practice is to display them in subdued light, such as normal household lighting, as far from the light source as possible and away from direct sunlight. Whenever possible, avoid temperatures above 21°C (70°F), humidities above 50 percent RH, and damaging chemicals and fumes. If less than ideal conditions are unavoidable, make an exhibition print, with the realization that its life is limited.

Select the print material that best suits your needs. Because of all the factors that can affect the life of a color photographic print—light, heat, humidity, atmospheric contaminants—a print that is on continuous display, even under the best conditions, is likely to change in time. If such prints are intended for display, arrange to have the negative or slide stored properly so that new prints can be made if the original prints begin to fade. Among the most stable prints, when they are stored in the dark, are those made by the dye transfer process, and this method should be given serious consideration whenever long-term preservation is anticipated for a print. Prints made on KODAK EKTACOLOR 78 Paper and EKTACOLOR 74 RC Paper from negatives can be expected to have a long life if they are kept and viewed as described above. These prints will exhibit equal or better longevity than dye transfer prints when storage in the light is required. The same is true for prints made by printing transparencies onto KODAK EKTACHROME 2203 Paper. KODAK EKTACOLOR 74 DURATRANS Print Material is a tough translucent print material that can be used for making prints from color negatives and that can be viewed by reflected or transmitted light. These properties make it useful for such applications as illuminated displays, exhibits, and transit advertising. In transmission viewing, too much light will adversely affect the print quality, and so some experimentation with the light level may be necessary.

Processing Affects Keeping

Commercial processing laboratories are aware of the important part that processing plays in the permanence of prints, negatives, and slides. If you do your own processing, remember that failing to follow the manufacturer's processing recommendations can impair image stability; for example, insufficient time in certain solutions or inadequate rinsing and washing can leave unwanted chemical residues.

Dehumidifying with Silica Gel

If photographic materials are enclosed in an airtight container when the atmosphere is humid, conditions within the container remain the same as those under which the package was sealed. In exceptionally humid conditions, when no other means of reducing relative humidity is available, a desiccant such as silica gel can be used as a temporary drying agent. If silica gel is enclosed with the photographic material, the silica gel absorbs moisture and so lowers the humidity in the container.

Silica gel is like a sponge; it absorbs moisture in considerable quantity. It does not react with most common materials, and it can be reused after it has been dried in an oven at about 175°C (350°F). Forty grams, or 1½ ounces, of silica gel are enough to keep the relative humidity at a reasonable level in about 30 cubic decimetres, or 1 cubic foot, of sealed space. Packages that are convenient for photographic use are produced by such companies as, for example, the Davison Chemical Division of W. R. Grace and Company, Baltimore, Maryland.

Silica gel is not recommended as a means of protecting processed negatives, slides, or prints in long-term storage.

Specifications for Archival Packaging Materials

Some of the by-products of paper and plastics manufacture are harmful to photographic products and must be removed before these materials can be used for mounting or storing photographs and negatives. Acids, peroxides, plasticizers, metal particles, wood fibers, sulfites, nitrates, and chlorides should be absent from mounting board, interleaving paper, album covers and pages, and plastic sleeves and sheets. Archival-grade materials are available from some photographic supply houses, but you must specify this grade. Art dealers also can often direct you to sources for these materials, which include, for example, Light Impressions, Rochester, New York, and Talas Division of the Technical Library Service, New York City.

If you do not know whether a material you are using is archival, you can test for its photographic activity. A simple, straightforward test is described in American National Standard PH1.53-1978, *Requirements for Photographic Filing Enclosures for Storing Processed Photographic Films, Plates, and Paper.* This Standard also includes specifications for paper, plastics, adhesives, and inks and for the construction of storage envelopes. It can be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018. The price is $3.75. Another ANSI publication that you might find helpful is PH1.43-1979, *Practice for Storage of Processed Safety Photographic Film.*

Restoration of Faded Transparencies

Two methods have been devised by which slides made on EKTACHROME Film that have changed materially in color balance during dark storage can be returned to a reasonable facsimile of the original when it was new.

Method 1, the Dupe-Mask Technique, merely requires two white-light exposures onto one sheet of duplicating film. The first exposure is made through the registered combination of the original and its duplicate (showing the fade of the original), and the second exposure is made through the faded original alone with standard white light modified to withhold exposure in the faded dye layer. Anyone familiar with color duplicating can restore faded transparencies by this technique.

Method 2, the Flashed-Dupe-Mask Technique, is recommended for those who do not wish to make split white-light exposures. The flashed mask resembles the dye that has been lost in the original. The effectiveness of the mask can be visualized by examining the combined mask and original on a standard illuminator.

Working instructions for Methods 1 and 2 can be obtained by writing Customer Technical Services, Consumer/Professional and Finishing Markets, Eastman Kodak Company, Rochester, NY 14650. Other restoration techniques are under investigation, and if information on them is available when you write, it will be sent to you.

Professional dye transfer laboratories also can make dye transfer prints of very acceptable quality from slides and sheets of EKTACHROME Films that have altered color balances due to storage.

In future years one of your assets will be the ability to provide reprints of your important images. Kodak suggests that you seriously consider the preservation of your important negatives to maintain the quality of your images. The information contained below will assist you in meeting this objective.

KODAK Storage Envelopes for Processed Films

These envelopes enable the photographer to store valuable negatives or transparencies effectively against atmospheric conditions (humidity and gases) and at lower temperatures that will minimize dye loss. The table below shows the dramatic increase in image stability when properly stored at lowered temperatures.

Effect of Temperature on Dye Fading Rate (40% relative humidity)

Storage Temperature	Relative Storage Time*
30°C (86°F)	½
24°C (75°F)	1
19°C (66°F)	2
12°C (54°F)	5
7°C (45°F)	10
−10°C (14°F)	100
−26°C (−15°F)	1000

*These values do not apply exactly to all color photographs, but they are close enough for most practical purposes.

These envelopes are available in two sizes:

	CAT No.
4 x 5 (50 envelopes to a pkg)	148 6398
8 x 10 (50 envelopes to a pkg)	149 0028

KODAK Storage Envelopes can be ordered through your dealer handling Kodak professional products.

Consumer/Professional & Finishing Markets
EASTMAN KODAK COMPANY, ROCHESTER, N.Y. 14650

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